Hydrogen Peroxide and Sugar

Most people know that Hydrogen Peroxide (H2O2) is commonly used for cleaning cuts and sores, and that a bottle of hydrogen peroxide can turn a brunette into a blonde. Yet, how many people know that hydrogen peroxide **can also be used as a powerful rocket fuel**? And how many people know that hydrogen peroxide accelerated the jet car Peroxide Thunder to 450 mph in 3.4 seconds?

Hydrogen peroxide is commonly used (in very low concentrations, typically around 5%) to bleach human hair, hence the phrases "peroxide blonde" and "bottle blonde". It burns the skin upon contact in sufficient concentration. In lower concentrations (3%), it is used medically for cleaning wounds and removing dead tissue. Combined with urea as carbamide peroxide, it is used for whitening teeth.

*Hydrogen peroxide tends to decompose exothermically into water and oxygen gas. The rate of decomposition is dependent on the temperature and concentration of the peroxide, as well as the presence of impurities and stabilizers. The use of a catalyst (such as manganese dioxide, silver, or the enzyme catalase) vastly increases the rate of decomposition of hydrogen peroxide. High strength peroxide (also called high-test peroxide, or HTP) must be stored in a vented container to prevent the buildup of pressure leading to the eventual rupture of the container. In the 1930s and 40s, Hellmuth Walter pioneered methods of harnessing the rapid decomposition of hydrogen peroxide **in gas turbines and rocket engines.***

*Hydrogen peroxide works best as a propellant in extremely high concentrations **of 90% or higher**.*
Hydrogen peroxide - Wikipedia Online Encyclopedia

Hydrogen peroxide (H2O2) can store energy in the **form of chemical energy**, similar **to hydrogen**. However, H2O2 has the same problem that hydrogen has - that is, hydrogen peroxide - H2O2 - does not exist naturally in large pools like crude oil: H2O2 is not a source of energy like oil; we can't go out and explore for it or drill for it. Hydrogen peroxide is manufactured by a process that consumes energy, and/or other chemical resources.

Hydrogen peroxide, when used to produce energy, creates only pure water and oxygen as a by-product, so it is considered a *clean* energy like hydrogen. However, unlike hydrogen, H2O2 exists in liquid form at room temperature, so it can be easily stored and transported. Hydrogen

peroxide has been around for a long time, so there is a long history of industrial handling and storage. Scientists are familiar with hydrogen peroxide.

Scientists know that hydrogen peroxide can be prepared by the anthraquinone process. This conventional chemical process **requires very large and expensive installations**, so there are relatively few manufacturers around the world. As a result, transport costs increase the price, making it uneconomical to deliver in small quantities or remote areas.

However, the variable and raw material costs for the anthraquinone process are low, says chemical engineer Erik Bengtsson.

"*The variable cost of production (raw materials, electricity and steam consumption) in modern plants is typically $150/ton H2O2, which corresponds to 34 cents/gallon for 50% conc. water solution of H2O2. Added to the variable costs, there are the fixed costs of production which are the capital cost, - around $150/ton at 15% return on investment, and the fixed costs of maintenance and operation, -around $50/ton. The sales price to big customers, like pulp bleaching plants vary from $350 up to $600, depending on the demand/supply balance on the market. Right now I believe the sales price is around $550/ton or $ 1.25 per gallon for 50% product. The much higher sales prices one can see on the market is for small quantities to small customers. The cost of production would decrease if there was a new big market area, like your suggested fuel market, because of the economy of scale.*

"*More than half of the variable cost is **for hydrogen**. The hydrogen is typically produced from natural gas, but it can also be produced from electrolyses of water, if the electric power is cheap enough.*

"*The anthraquinone process is a very smart process: It uses the anthraquinone to combine hydrogen and oxygen from the air to form H2O2, in a safe and efficient way, but the anthraquinone is not consumed, it is recycled in the process. And, as I said before, one can use renewable electricity for producing the hydrogen needed. One can also **use bio gas.***"
— Erik Bengtsson
www.PeroxidePropulsion.com

Recent **advances in electrochemistry have demonstrated** the feasibility of producing hydrogen peroxide by the electrochemical reaction of oxygen and hydrogen in a fuel cell. The new process could significantly reduce the cost of producing hydrogen peroxide and provide an opportunity to make the H2O2 from hydrogen and oxygen generated locally with renewable resources.

Patent# 6,685,818 Process for the electrochemical preparation of hydrogen peroxide - February 3, 2004

One of the problems Engineers must solve when designing a process for making hydrogen peroxide is the high loss of energy. The typical energy conversion efficiency is less than 50% because the formation of H2O2 produces heat as a by-product.

In the future, Microreactors may be used to solve this problem: Microreactors could redefine chemistry, nanodrip by drop

Research Scientists at the University of Liverpool, England have another idea: *To realize hydrogen peroxide's full potential, industry needs* ***a simple production process*** *which can be implemented at the point of use, and provide high energy conversion efficiency*...

We've all heard about the automotive industry's efforts to replace the internal combustion engine with a more environmentally friendly alternative. The most promising approach involves a new kind of battery – the 'fuel cell'. Chrysler and Volkswagen are already using fuel cell technology in some of their vehicles; powered by a conventional electric motor which is quieter and simpler than the internal combustion engine, they deliver similar acceleration – and no noxious exhaust emissions.

The fuel in question is a mixture of hydrogen and air. Together, they generate a controlled chemical reaction in the fuel cell, producing electrical energy, and water as a by-product. There are two stages to the chemical reaction: at the end of the first stage, hydrogen peroxide is produced; in the second stage, the H2O2 is converted to H2O – ie water.

In road vehicles, engineers try to maximise the energy output by avoiding the formation of H2O2. It doesn't take a huge leap of imagination to recognise that it might be possible to tweak the chemical reaction to produce H2O2 instead of H2O – and to maximise the production of H2O2 rather than electrical energy. A US research group has already sought patent protection for a fuel cell designed to generate H2O2 in a two-stage process – but it has not yet worked in practice.

One-stage process

In 1999, it struck a group of electrochemists in Liverpool University's Department of Chemistry that it should be possible, using fuel cell technology, to generate H2O2 in a one-stage process. "Our idea", explains Professor David Schiffrin Director of Liverpool University's Centre for Nanoscale Science, "was to prevent the conventional reaction in the fuel cell from proceeding

to the second stage, which converts H2O2 to H2O – and to use a quinone rather than platinum as the catalyst."

At their very first attempt, the research partners achieved their goal – with 98% efficiency. They soon increased this to 100% efficiency. In the process, they made an important discovery: it is possible to get hydrogen to produce electrons automatically – within the reaction, but physically separate from the oxygen producing the hydrogen peroxide.

Having demonstrated the feasibility of the electrochemistry, the next step was to incorporate it within a fuel cell. "Our approach should enable hydrogen peroxide to be produced using a clean technology – with surplus electrical energy as its by-product", comments David Schiffrin. "It could also give Europe an opportunity to secure a lead in the development of fuel cell components and systems for electrosynthesis."
Taken from: A New role for fuel cells

When scientists talk about hydrogen peroxide as a fuel, they use the word "decomposition" instead of saying the fuel is "burned". When hydrogen peroxide is used as a fuel, energy is released in the form of heat during the rapid decomposition of H2O2 to H2O, creating steam and oxygen. In the case of high concentration H2O2, much of the energy takes the form of an enormous thrust - propulsion - as demonstrated by the jet car and rockets.

Hydrogen peroxide "decomposes" into pure water: the H2O2 molecule changes into H2O + 1 free O (water + 1 free oxygen atom) creating a lot of heat in the process. H2O2 was used during World War II as fuel for underwater torpedoes because it "burned" without the need for an outside air supply. The trail of air bubbles that can be seen behind the H2O2 powered torpedo is evidence of the free oxygen released during decomposition of the H2O2 into H2O.

H2O2 decomposition releases pure oxygen as a by-product. Scientists found that the pure oxygen by-product could be used for "burning" carbon during the H2O2 decomposition—the heat would cause the carbon and free oxygen to ignite and "burn". In this way, the heat energy of **the H2O2 fuel can be increased significantly**.

Delchev Fuel:

An inventor, who lives in the Mojave desert near Death Valley California, has developed a renewable fuel made from a mixture of hydrogen peroxide and sugar. The inventor's name is Nick Delchev.

Delchev Patent#4,698,965 Hot gas source and fuel therefor

A method, apparatus and the fuel therefor for creating a hot gas jet from hydrogen peroxide in a maximum aqueous solution of 55% to which is added a burnable substance. The mixture is passed through a permeable mass of catalytic material such as manganese dioxide in the form of granules of natural pyroluside where the hydrogen peroxide is broken down into water and oxygen. The oxygen thus formed is combined with the burnable substance which may be sugar, coal dust, alcohol, gasoline or other common fuels. Water is added to the mixture to insure storage stability of the hydrogen peroxide.

BACKGROUND OF THE INVENTION

The field of the present invention is means for generating hot gas.

Since at least as early as World War II when the German V-2 rocket employed hydrogen peroxide in combination with permanganate as catalyst to run a turbine, the concept of rapidly converting hydrogen peroxide to water and oxygen for use as a source of hot gases has been known and used. More recently, a land speed record vehicle employed a permeable mass of catalyst in the form of silver screens through which hydrogen peroxide was forced. The steam and oxygen created by this process was then used as a pure rocket to drive the vehicle to several hundred miles an hour. However, difficulties exist with the use of hydrogen peroxide because of its rather unstable nature when found in substantial concentration. Consequently, this substance has found little utility in more mundane uses for creating such a high temperature, pressurized gas.

The resulting products from the decomposition of hydrogen peroxide are water and oxygen. These products are advantageously harmless to both the environment and humans. Thus, use of such a source in confined or controlled areas does not present a problem from the standpoint of the generated exhaust.

SUMMARY OF THE INVENTION

The present invention is directed to a hot gas source and the fuel therefor using hydrogen peroxide in combination with other substances presented **in a safe form** to realize maximum power benefits from the hydrogen peroxide. The concept of passing hydrogen peroxide

through a catalyst to rapidly decompose the substance to water and oxygen has been combined with the introduction of a burnable substance. This substance may be one of a very large variety of substances which can be oxidized in the environment of the decomposition of hydrogen peroxide. Among the possible substances which may be combined with the hydrogen peroxide are alcohol, sugar, coal dust, gasoline and other common fuels. To stabilize the hydrogen peroxide, it has been found that a substantial amount of water may be added to the hydrogen peroxide. This additional water is converted to steam in the process.

The introduction of the hydrogen peroxide and burnable substance makes use of the free oxygen which is a product of the decomposition of hydrogen peroxide. In fact, it is believed that the oxygen is atomic rather than molecular, as it first separates from the hydrogen peroxide. Thus, the oxygen is even more susceptible to combining with the burnable substance. If a proper mixture is used, such that a near stoichiometric ratio is combusted, the resulting combusted gases include steam, carbon dioxide, and oxygen. Consequently, the system is very clean burning in that **carbon monoxide and free hydrocarbons can be virtually eliminated**. Furthermore, as air is not employed in this system, **no NOx** would normally be formed.

Thus, a high energy, practical and **polution-free hot gas source is created by the present invention**. Accordingly, it is an object of the present invention to provide an improved source of hot gases including both a device and the fuel used therewith.

DETAILED DESCRIPTION...

The fuel contemplated for this device is, as stated above, a stable hydrogen peroxide in combination with a burnable substance. The burnable substance is preferably in a concentration near but below the stoichiometric ratio. By providing combustible material below the stoichiometric ratio, full combustion of that material is insured, with a portion of the oxygen remaining uncombined. As a result, with the exception of impurities in the fuel mixture, hydrogen peroxide and a hydrocarbon or carbohydrate will create water and carbon dioxide with oxygen left over. At or above the stoichiometric ratio, not all of the burnable substance will be properly oxidized to these simple and harmless substances. The amount below the stoichiometric ratio needed to insure clean burning depends to a substantial extent on the mixture and particularly the burnable substance used. Empirical observation is best used to determine the exact ratio most advantageous to each mixture.

*The decomposition of the hydrogen peroxide by itself **does not create the temperatures** contemplated by the present invention. A 50% aqueous solution of hydrogen peroxide passed*

through the manganese dioxide catalyst will raise the temperature of the device to approximately 395.degree. F. However, ***with the addition of the burnable substance such as listed above,*** *the operating temperature of the device is in the range of* ***1000.degree. to 2000.degree.*** *F, depending in part on the fuel employed, its concentration, the nozzles employed and the rate of feed. As a result, the combustible material adds significantly to the coloric output of the system. Additionally, in order to achieve full combustion in such contemplated burnable substances as alcohols and sugar, for example, it is necessary to raise the temperature of the device to something above 800.degree. F. For this reason, it is advantageous to simply provide a glow plug to initiate localized combustion.*

The optimum combination found to date limited by maximum thermal output and mixture stability is 40% hydrogen peroxide, 40% water and around 20% burnable substance approaching ***the stoichiometric ratio of the material selected.*** *In the case of sugar, 20% sugar by weight has been found highly satisfactory with 40% hydrogen peroxide and 40% water. This may generally be prepared, either before reaching the combustion chamber or at the combustion chamber, by mixing an aqueous solution of 50% hydrogen peroxide with sugar to arrive at the foregoing percentages by weight. If a higher percentage of hydrogen peroxide in the fuel mixture above about 42% is employed, (55% aqueous solution with burnable substance added) an insufficient margin of safety exists. Aqueous hydrogen peroxide in percentages of* ***63 1/2% or greater are generally unstable.*** *At lesser percentages of hydrogen peroxide, the thermal advantages are reduced. The minimum necessary to support burning under ideal conditions has been found to be 19.7% hydrogen peroxide, 7% sugar and the rest water, by weight.*

The utility of the method and apparatus defined here is substantial and varied. As with the aforementioned land speed record vehicle, the device may be used as a simple propulsion rocket. The device may also be used to drive turbines, to fill voids with hot steam, to provide a source of steam, or to provide a source of heat. Thus, the present apparatus and method have wide utility and allow the clean burning of a very wide range of materials.

While embodiments and applications of this application have been shown and described, it would be apparent to those skilled in the art that many more modifications are possible without departing from the inventive concepts herein. The invention, therefore, is not to be restricted except by the spirit of the appended claims.

U.S. Patent# 4,698,965

Nick Delchev — Inventor

Nick Delchev standing next to his prototype H202 turbine engine that he built to demonstrate his invention in a modified Volkswagen.

As the Sugar web page shows, every community in America has **plenty of waste biomass that can be converted to sugar.** And, **as the patents on this page reveal**, renewable electricity or off-peak electricity from nuclear energy can provide a non-carbon energy source to make fossil-free hydrogen peroxide.

The mixture of sugar and hydrogen peroxide produces a renewable liquid fuel that can be stored for long periods - weeks, months, years - and used when needed to power automobiles or to heat homes, factories and office buildings, or to power steam turbines for producing electricity during peak-time demand. The H2O2+sugar "Steam on demand" can be used as backup power to insure a level output from renewable energy sources such as wind energy, thus enabling wind and other intermittent energy sources to offer a guaranteed steady electrical supply for the grid 24 hours a day, 7 days a week.

Much attention has been given to ethanol, and less has been given to sugar as a combustible fuel additive. The extraction of the sugar molecules from biomass is much less expensive than the fermentation of the extracted sugar into ethanol. This is because the fermentation process requires one or two days, tying up the production line. In contrast, the sugar extraction process requires **only a couple of hours**. If a sugar extraction facility is dedicated to only

producing sugar from the cellulose and hemicellulose portions of biomass, freed from the fermentation to ethanol process, the facility could produce far more sugar and provide a higher return on investment... If there was a market for the low-cost sugar.

For 20 years, Nick Delchev has dreamed about and worked toward the development of a car that will run on Hydrogen Peroxide and sugar. Nick Delchev has built and demonstrated a steam engine powered by his fuel mixture and invention. The fuel is about 40% H2O2 by volume (after the sugar and pure water have been added). A 40% H2O2 solution will *burn the skin upon contact*, but if people are careful, it is not dangerous—the 40% solution is stable (though you would still need to be careful, just as you would be with gasoline).

Three gallons of the Delchev fuel equals about the same BTU's as one gallon of ethanol. At 65 cents per gallon, three gallons of the Delchev fuel would be competitive with the cost of one gallon of ethanol (providing about the same thermal combustion energy). But... Nick's invention combined with a steam turbine engine would produce more power from two gallons of his H2O2+sugar fuel than one gallon of ethanol would produce in a normal piston engine. So, two gallons of the Delchev fuel could produce the work/mileage of one gallon of ethanol, in a car designed to run on the Delchev fuel.

Are people willing to double the size of their fuel tanks, if doing so would free America from dependence on oil?

In addition, the Delchev fuel burns cleaner than ethanol. Virtually all carbon monoxide and NOx would be eliminated, making the Delchev fuel as clean as hydrogen, because the CO2 would be recycled from the atmosphere when new biomass is grown to supply the sugar extraction facility.

The Delchev fuel (the H2O2 + sugar mixture) provides an opportunity to merge biomass energy with wind, solar and hydro energy by making the H2O2 from the renewable electricity. And in so doing, the Delchev fuel acts as storage for the wind, solar and hydro electricity.

The Delchev fuel can completely replace home heating oil. No need for boilers - steam is the product of H2O2 decomposition. The H2O2+sugar fuel can produce steam that will also power a turbine for electricity and provide heat from the steam as well.

The Delchev fuel can also power a modified diesel engine (converting the diesel engine into a steam engine), for example, replacing the huge diesel motors that drive the pumps that push our water through large aqueducts up and over mountains and hills.

The Amendola patent, described below, may offer a possible replacement for diesel engines, eliminating the need for diesel fuel used by commercial trucking.

Amendola Patent# 6,250,078 Engine cycle and fuels for same
An engine cycle that is carried out in a reciprocating piston/cylinder engine consists of a working stroke in which exothermic decomposition of at least one liquid compound is caused to occur without combustion so as to produce a gaseous product of the decomposition that drives the piston along the cylinder in one direction and an exhaust stroke in which the products of the decomposition are exhausted from the cylinder upon return movement of the piston.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a high power, high efficiency engine cycle that is carried out in a reciprocating-piston engine. Another object is to provide an engine cycle that operates with no pollution or very low pollution by virtue of the nature of the "fuels" used. By utilizing a different set of fuels in combination with an engine constructed to utilize the power cycle of the present invention, many problems common to today's fossil fuel, air-aspirated, piston engines, are eliminated. The engine cycle of the present invention has been named the "Amendola cycle," and an engine operating with the Amendola cycle is sometimes referred to hereinafter as the "ACE."

... Another advantage of the engine cycle of the present invention is that the expansion ratio can be made quite high if desired for high efficiency engines. In existing engines the expansion ratio is the same as, and therefore limited by, the compression ratio, which in turn, is limited by the quality of the fuel used. This fuel quality is expressed as an "octane number" for spark ignition engines and a "cetane number" for compression ignition engines. Most spark ignition engines rarely exceed compression ratios of 12:1 with between 8:1 to 10:1 being the most common. With compression ignition 20:1 ratios are possible with 14:1 to 18:1 being the most common. However, the more efficient compression ignition engines are only efficient at rather steady conditions and respond poorly to load changes. This lowers the desirability of using diesels in transportation since they emit large amounts of pollutants while the load conditions are changing.

With the ACE, since there is no compression stroke, there is no preignition of the fuel (the key limiting factor of compression ratio) and the expansion ratio can be made as high as desired. The only limitation is the mechanical ability to make a large expansion ratio. In practice the ideal efficiency for a 10:1 system according to equation (1) would give work of, RT(2.3). A

100:1 system would give RT(4.6). So a ten-fold increase in compression ratio doubles the extracted work. However, even just going to 30:1 gives RT(3.4), a 50% increase in work output.

The Amendola patent is describing a piston steam engine powered by H2O2.

If it is true that a steam engine does not need a compression cycle, therefore allowing the expansion ratio to be increased significantly, then, I ask, have existing steam engines been designed to take advantage of the higher expansion ratio described in the Amendola patent?

Because the steam engine has existed for more than a century, why do we need a new patent? It seems to me that by combining the Delchev Patent (described previously) with a known steam engine design, you would have all the benefits described by the Amendola patent. Am I missing something?

Information Links:

Introduction to Hydrogen Peroxide
The History of Hydrogen Peroxide Propulsion
When was H2O2 discovered and how is it produced?
Nanostructures for Energy and Chemicals Production
Patent# 6,807,805 Hypergolic fuel system - October 26, 2004
Patent# 6,712,949 Electrochemical synthesis of hydrogen peroxide
Novel high performance steam engines - a better solution than Fuel Cell and ICE?
Patent# 6,592,840 Highly pure aqueous hydrogen peroxide solutions, method for producing same and their use
Patent# 5,645,700 Polymer membrane based electrolytic cell and process for the direct generation of hydrogen peroxide in liquid streams

Hydrogen Peroxide web sites:

www.PeroxidePropulsion.com
Experimental Rocket Propulsion Society

Recommended reading:

Our Energy Challenge by Nobel Laureate Dr. Richard E. Smalley

Zero Interest Financing —Investment Capital for American Energy Independence Projects